ISDN Line Simulator
ILS-C
User's Manual

TELTONE®

enhancing communications

40-400-00012, Rev. E

Note
This manual covers Models ILS-C-01 & ILS-C-02.

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IMPORTANT USER SAFETY INSTRUCTIONS

When using this product, basic safety precautions, including the following, should always be followed to reduce the risk of fire, electric shock, and injury to persons.

1. Read and understand all instructions.
2. Follow all warnings and instructions marked on the product.
3. The product should be operated only from the type of power source indicated on the marking label. If you are not sure of the type of power supply, consult your dealer or local power company. The product is designed for indoor use only.
4. To reduce the risk of electric shock, do not disassemble the product, but take it to qualified service personnel when service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect reassembly can cause electric shock when the appliance is subsequently used.
5. If the product does not operate normally by following the operating instructions, or if the product has been dropped or the cabinet has been damaged, or if the product exhibits a distinct change in performance, refer servicing to qualified service personnel.
6. If the product is used in a manner other than specified in this manual, the protection provided by the product may be impaired.
7. For the purpose of removing power from the product, the power input connector is the main power disconnect point. Pull the power cord away from the connector to ensure power disconnect.
8. Adequate air flow must be maintained in order for the product to operate correctly. Do not wrap the product in blankets, paper, or other material that may impede ventilation.

CAUTION: THIS PRODUCT CONTAINS ELECTROSTATIC SENSITIVE DEVICES. USE APPROPRIATE HANDLING PROCEDURES.

REGULATORY COMPLIANCE

FCC Part 15 Class A Notice: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

ISDN Line Simulator

INTRODUCTION

ISDN (Integrated Systems Digital Network) is a system which combines telephone and computer networking in a digital medium. The ISDN-BRI (Basic Rate Interface) is the interface for individual users to connect to the public telephone network. An ISDN BRI is composed of three separate channels of information called 2B+D, that is, two full duplex Bearer channels and one full-duplex Data channel combined onto a single pair of wires.

The Teltone ILS-2000 (ISDN Line Simulator) is two ISDN BRI connections in a portable unit. The user interface is either a “U” or an “S/T” connection using an RJ45 modular plug. The “U” connection is similar to the interface that is provided by a local telephone service provider (LEC), such as one of the Bell Operating Companies, or an independent telephone company. The “S/T” connection uses a built in NT-1 (Network Termination 1) to connect to Terminal Equipment that includes TE1s, TAs, and TE2s. Using these connections, the user is able to place calls, either voice or data, or both, using the National ISDN-1, AT&T 5ESS, Custom DMS100, or ETSI.

ISDN is based upon an OSI (Open System Interconnection) model. The ILS-2000 supports layer 1 (physical operation), layer 2 (data link operation), and Layer 3 (network operation.) Layers 4-7 are considered application layers that use the first 3 layers as a base.

The ILS-2000 ISDN Line Simulator has been developed to make the transition from traditional telephony to ISDN networking easier. Software developers, manufacturers, integrators, and sales representatives now have an ISDN-BRI *server in a box*. The ILS-2000 supports ISDN-BRI end-to-end operation, multiple Call Control protocols, telephony switch services, and simple functional operation on the desktop or lab bench.

UNPACKING

Carefully unpack the items in the shipping container and verify that you have received the following:

1. ILS-2000 ISDN Line Simulator
2. 115 VAC Power Cord
3. This User Manual
4. Windows® based ILS-2000 Configuration Software diskette
5. Product Registration Card
6. DB9F-DB25M 6-ft RS-232 cable (p/n 742-00022-01)
7. DB9M-DB25F adapter (p/n 742-00020-01)

CHAPTER 1: QUICK START

The ILS-2000 Line Simulator is easier to operate than most communications devices designed for ISDN-BRI applications. It functions in the background, providing two lines of end-to-end ISDN-BRI service.

Because the Simulator was designed primarily for people who demonstrate, functionally test, or configure ISDN-BRI devices, you do not need to understand ISDN protocols or read the entire User's Manual to use it. Simply follow the instructions outlined below to successfully simulate most ISDN-BRI communications devices and computer applications.

Step 1 Place the Simulator on a flat surface near the ISDN equipment to be connected.

Step 2 Insert the power cord into the three-pronged outlet located at the rear of the Simulator. Plug the other end into a standard 115 VAC, 60 Hz wall outlet. **NOTE:** This unit is set at 115 VAC operation at the factory. 230 VAC power may be used, see Chapter 5 for details.

Step 3 Connect the ILS-2000 to your computer's serial port using the supplied RS-232 cable, and if needed, the supplied DB-9M to DB-25F adapter.

Step 4 A 3.5" diskette is provided with the ILS-2000 to change the configuration of the unit. To install this windows based software, place the diskette in the appropriate drive and from Windows Program Manager, select FILE, RUN, A:Setup.

Step 5 Start the ILS Configuration Program.

Step 6 Apply power to the Simulator by pressing the power switch - located at the rear of the Simulator - to the PWR ON position. An internal self-test will begin. **Please wait 60 seconds before attempting to place any ISDN calls. This will give the ILS-2000 time to complete its self test.**

Step 7 The Simulator is configured at the factory for National ISDN-1 protocol. The Simulator is provisioned for default service, as normally practiced for the selected switch type. Most communications devices operate correctly with this provisioning. However, if your communications device does not operate correctly, you may need to change the Simulator's provisioning. These settings are fully described in Chapter 3.

NOTE: The instructions for many ISDN-BRI communications devices may specify Switch Provisioning required of the telephone company. Provisioning is a means of configuring the ISDN switch so it knows what kind and how many calls your communications devices can handle, up to the limits imposed by ISDN-BRI technology. Provisioning also specifies which types of

Supplementary Services your equipment may request, such as call appearances, display support, etc.

Step 8 After the Simulator's provisioning is established and downloaded, the settings are retained in non-volatile memory until you change them. You now have two ISDN-BRI telephone lines ready to provide Circuit Mode Voice (Speech, 3.1 kHz Audio, 7 kHz Audio), and/or Circuit Mode Data (56 Kbs Restricted, 64 Kbs Clear) services on two B Channels.

Step 9 Refer to the instructions supplied by the manufacturer for installing your communications device or computer application on an ISDN-BRI telephone line. For most devices, you will use a procedure similar to the following:

NOTE: The instructions may specify that your communications device requires power from a secondary source, such as a wall adapter. It may not be necessary to connect a power source when using the Simulator. See Specifications for more details.

Step 10 Determine which ISDN-BRI interface is compatible with your device. The interface may be either S/T or U. The S/T Interface is commonly called the "Phone" outlet from an NT-1 and is used for most end-user communications devices. However, some adapters and communications devices connect to the U Interface, also called the "Line" outlet. Use 8-Pin Modular (RJ-45) telephone cord for all connections.

IMPORTANT: Either or both Simulator ports may be used during simulation, but only one interface (S/T or U) may be selected at each port. The Simulator auto-detects the active interface. If both interfaces at one port are connected, the Simulator defaults to the S/T interface.

If your communications device is compatible with the S/T Interface, connect to the Simulator's S/T Interface at either port. Some instructions may require that the device be connected to the "Phone" outlet of an Network Termination-1 (NT-1) device. If you do not have an NT-1 available, use the Simulator's S/T Interface.

Step 11 If you have an NT-1 and want to install it between your device and the Simulator, connect the NT-1 "Line" outlet to the Simulator's U Interface at either port. Allow several seconds (5-30) for the port's U-SYNC light to turn green, then connect your communications device to a "Phone" outlet on the NT-1. Most NT-1's provide two "Phone" outlets, providing a convenient method for connecting two devices at each Simulator port.

NOTE: The Simulator's U-SYNC light shows synchronization only for the U Interface. The U-SYNC light is not an indicator for the S/T Interface, which synchronizes in less than a second.

Step 12 Next, you may be instructed to program one or more identification numbers into your communications device or computer application. The numbers may be a Service Profile ID (SPID) and sometimes a telephone number (Directory Number or DN). The Simulator, like an ISDN switch, expects specific SPID's and DN's to be assigned to any particular port. When programming these numbers into your communications device, you must assign the number(s) listed in the following table:

First device at Port 1:	SPID 0835866101
	DN 835-8661 (1-800-835-8661)
Second device at Port 1:	SPID 0835866301
	DN 835-8663 (1-800-835-8663)
First device at Port 2:	SPID 0835866201
	DN 835-8662 (1-800-835-8662)
Second device at Port 2:	SPID 0835866401
	DN 835-8664 (1-800-835-8664)

NOTE: Not all communications devices are programmed with a SPID or DN. Some devices need an additional number called a Terminal Endpoint Identifier (TEI). If you must assign a TEI, use a different number (between 1 and 63) for each device you connect to the Simulator. If automatic TEI assignment is a selectable option, choose it. In short, follow the instructions for your device, using the numbers listed above, when applicable.

Step 13 After any identification numbers are programmed into your device, it notifies the Simulator using an initialization procedure. If the procedure is successful, and your device is connected to the U interface, the U-SYNC LED will light after synchronization is complete.

NOTE: If the U-SYNC LED does not turn on, the device may need to be rebooted or momentarily disconnected (powered down) and reconnected to make it initialize. If the device did not require SPID programming, the U-SYNC LED may not turn on until you place your first call.

Step 14 Repeat the above steps for additional devices. The Simulator provides power for up to four communications devices and two NT-1's. Each communications device must be programmed with a different SPID and/or DN.

Step 15 If you later need to rearrange the connections between the Simulator and your devices, disconnect the devices from the Simulator. Restart the unit by either repowering the unit or

using the configuration interface on a PC connected to the RS-232 port. Then reconnect your devices. If you move a device from one port to another, its SPID and DN must be reprogrammed using available numbers from Table 1. You do not need to restart simulation if you change a device's SPID or DN when it remains at the same port.

IMPORTANT: Some devices let you change the ISDN protocol to support the type of ISDN switch the telephone company has installed. If you change your device's protocol, you must change the Simulator's Switch Type configuration to match. If you change any one device's ISDN protocol, then all devices connected to the Simulator must be configured for that protocol.

Step 16 Now you can operate your devices as recommended by the manufacturer.

ILS-2000 Operation

In general, your ISDN-BRI device will operate the same as conventional telephone equipment, with the obvious exceptions that call processing occurs more rapidly and that voice, high-speed data, and packet mode data may be sent and received simultaneously.

To call from one device to another, you must connect at least two devices to the Simulator. To place a call from device 1 to device 2, dial either the local DN or long distance DN associated with device 2. For example, to call from device 1 (DN= 835-8661) to device 2 dial the local Directory Number 835-8662 or the long distance number 1-800-835-8662.

If you dial one of the valid Directory Numbers, but no device was assigned to that number, you will hear a ringing tone. If you dial a number assigned to a device that is unable to accept the call, you will hear busy tone and be disconnected after approximately 45 seconds. If you dial a number that is invalid, you will hear a reorder tone (fast busy signal), which means the Directory Number is not in service.

If you dial the number correctly and the device is able to accept the call, the called device begins alerting (rings). When the call is answered, a connection is established between the devices. You may then talk, transfer files, share computer applications, video conference, exchange e-mail, or perform any other service or feature your ISDN-BRI devices or computer applications support.

If your device supports putting a call on hold or placing multiple calls, you can make additional calls to other devices. You can also make calls in either direction. When you have completed the demonstration, hang up all calls to release their resources.

ISDN-BRI supports up to two connected voice and/or data calls on one line using the B Channels. More than two calls may be present, but any call exceeding the limit of two *connected* calls must be placed on hold. Some

devices, particularly those that support video conferencing or LAN adaptation, need both B Channels for a single call.

If your communications device requests any of these services, the Simulator provides the necessary processing and resources. A special case, which uses the D Channel and X.25 packet data transmission is also supported and may occur while both B Channels are connected. To enable this service, see Chapter 3 section on D Channel X.25 Packet Handling Function.

Some limitations apply to all ISDN-BRI communications, however. For example, if two devices are connected to a single line and you establish a call between them, both B Channels at that line are allocated to connect the call. In other words, both B Channels are "busy" during one connected call. Consequently, any device that uses two B Channels for a single call, such as a video conferencing application, cannot connect to another device on the same line.

Another limitation occurs when attempting to place a call to a device that does not support the requested call type. For example, a call placed from an ISDN data terminal to an ISDN voice telephone will be rejected by the telephone.

In some cases, the call type and number of channels are satisfied and the called device answers the call, but the calling application is not compatible with the called application. For example, not all video conferencing applications use the same data encoding. Or, a Terminal Adaptor that converts ISDN to RS-232 may answer a data call that is carrying FAX information. A well-designed application determines that it cannot process the data and releases the call. Otherwise the user must hang up.

What To Read Next

For a technical review of ISDN-BRI operation, including physical layer indications, data link packet protocol, and call control signaling, read Chapter 2.

For a comprehensive review of Simulator provisioning, read Chapter 3.

For more details about Simulator operation, read Chapter 4.

For troubleshooting guidelines, technical references, read Chapter 5.

CHAPTER 2: ISDN-BRI

Technology Overview

The Integrated Services Digital Network - Basic Rate Interface (ISDN-BRI) is a technology that gives individuals affordable access to the world's largest digital network using the copper wire currently entering their home or office. With ISDN-BRI, users may connect almost any form of personal communications device to a single phone line and establish multiple, simultaneous voice and data connections at speeds up to 128 thousand bits per second.

ISDN is an extremely robust networking technology based on the Open Systems Interconnection (OSI) model set forth in the International Standards Organization specification, ISO84.

The OSI model specifies a layered design architecture. Layer 1, or the physical layer, consists of two new interfaces, referred to as the *U and S/T Interfaces*. Layer 2, or the data link layer, is a packet transport protocol known as *Link Access Protocol - D Channel* (LAP-D), which was adapted from ITU-T Recommendation X.25. Layer 3, or the network layer, is a flexible switching and signaling language referred to as *ISDN Call Control*.

The ILS-2000 is configured to support the first three layers of the OSI model.

ISDN services are referred to as *Call Types*. Common call types are Circuit Mode Voice (CMV), Circuit Mode Data (CMD), and Packet Mode Data (PMD). Circuit mode call types support high-speed data and digitized voice, while packet mode calls may be used for computer networking.

All ISDN-BRI user traffic travels over two 64Kbs *B Channels* and one 16Kbs *D Channel*. The B Channels are always used for circuit mode calls and the D Channel is always used for transporting Call Control signaling packets between the ISDN switch in the central office and the end-user communications device. The B and D Channels may optionally transport user Packet Mode Data.

Layer 1 - Physical Operation

Typical ISDN-BRI terminations and interfaces are shown in Chapter 5. Each interface, which the telephone company terms a *reference point*, is designed for a specific task.

U Reference Point

This interface connects the central office to the customer's premises. It is a 160Kbs, two-wire, bidirectional transmission path that employs 2B1Q encoding to endure long distances. It is designed to provide as much bandwidth as possible over existing copper wire pairs. The U interface signal carries two B channels, one D channel, overhead bits for framing and echo cancellation, and an *Embedded Operations Channel* (EOC) for testing and monitoring.

Network Termination-1 (NT-1)

The U Interface terminates at a device called a *Network Termination-1*, or NT-1. This device converts the U Interface to an S/T Interface. It also permits loop back and testing by the telephone company and a means of routing local power to devices previously designed to receive power from the line, such as a telephone.

S/T Reference Point

This interface is a 192 Kbs, four-wire path; two wires are used for transmission, two for reception. The encoding scheme is ASI bipolar. Unlike the U Interface, it synchronizes quickly. All ISDN-compatible user devices, or *Type 1 Terminating Equipment* (TE-1), are connected directly to the S/T interface.

Terminal Adapters

To accommodate a variety of communications equipment, the S/T interface may be connected to a *Terminal Adapter* (TA). This device provides any necessary conversion from an older or proprietary interface, such as RS-232 or a Local Area Network (LAN) protocol, to an ISDN-BRI S/T Interface. Devices that connect to a TA are called *Type 2 Terminating Equipment* (TE-2).

Layer 2 - Data Link Operation

Layer 2 of the OSI model establishes a method of transporting binary information via data links. The ISDN data link layer is a variant of X.25 packet exchange called *LAP-D*. All signaling and switching information (Layer 3), and optionally X.25 LAP-B user data, are transported on the D Channel using this protocol. LAP-D packets are of variable length, and are bounded by a flag pattern and terminated with a cyclic redundancy checksum.

There are three categories of packet. Unnumbered Information (UI) packets carry LAP-D protocol commands. These commands establish addresses, initiate sequenced packet exchanges, or negotiate various protocol parameters. Numbered Information (I) packets carry Layer 3 Call Control messages or X.25 LAP-B user data. These packets are given sequence numbers, referred to as Next Send (NS) and Next Receive (NR), which ensure delivery in correct order. Supervisory (S) packets acknowledge or reject sequenced I packets.

Packet Addressing

Each packet is given an address consisting of two numbers. The first number, called a *Service Access Point Identifier* or SAPI, addresses one of three *logical links* or destinations within a device. SAPI 0 addresses Call Control functions, and SAPI 16 addresses the *Packet Handling Function* (PHF) associated with X.25 LAP-B user data.

SAPI 63 addresses the *Signaling Access Controller* (SAC), which negotiates and assigns the second packet address number, called a *Terminal Endpoint Identifier* or TEI. The TEI is a unique number for each Terminating Equipment on a particular line. For example, if a packet addressed to SAPI 0 and TEI 3 is sent to four ISDN devices connected to a single line, only the Call Control function (SAPI 0) of the device assigned TEI 3 will acknowledge and process the packet.

TEI Assignment

Most ISDN Terminating Equipment support a feature called automatic TEI assignment. After a device is connected and synchronized, packets are exchanged with the switch to establish the TEI. The switch knows which TEI's are assigned to that line and can query each device if in doubt. A unique TEI between 64 and 126 is then formulated and returned to the requesting device. TEI 127, the default broadcast TEI, is used for this operation. Some switches or devices do not support automatic assignment, however. The user is then responsible for configuring the device with a unique *fixed TEI* between 1 and 63.

Layer 3 - Network Operation

Once packet exchange is established, the Network Layers of the switch and Terminating Equipment can begin the Call Control dialog that replaces conventional telephony signaling. The dialog is based on a set of commands that operate on one or more parameters, similar to a computer Operating System language. Commands are called *Messages* and parameters are called *Information Elements* (IE). There are over 45 Messages and 65 Information Elements currently used by North American ISDN telephone networks. Information elements may contain between one and over 100 bytes of constant or variable data.

For example, the SETUP Message initiates an incoming or outgoing call on demand. Several Information Elements are contained in a SETUP Message, and each are expected to be a particular value or variable type. The SETUP Message usually contains the *Channel ID*, *Bearer Capability*, and *Calling Party Number* Information Elements, among others. The Channel ID determines which B or D Channel is used for the connection. The Bearer Capability describes the call as voice, high-speed data, or packet mode data and sets the data rate and other parameters. The Calling Party Number is the caller's Directory Number in ASCII code.

Other Messages and Information Elements enable tones, transport keypad numbers, alert the called party, connect the call across the network, and disconnect the call and release its resources when either party hangs up. Standardized Message types and Information Elements are listed in Chapter 5. Call Control is extensible, however, and the number of Messages and Information Elements continues to increase.

Multiple versions of ISDN Call Control currently exist. Two common ISDN switches use proprietary Call Control: Northern Telecom's DMS-100 series

and AT&T's 5E series. The Call Control standard to which these switches are being upgraded and to which current switches are designed is called *National ISDN-1*. The European Economic Community, (ECC) is currently consolidating various national versions to comply with the European Telecommunications Standards Institute (ETSI) protocol.

Consequently, Messages and Information Elements may differ in function and coding, depending on the switch and the vintage. A special Message, NETwork ESCape, is implemented to alert the switch when a proprietary Message coding is used. Information Element codings that are not yet adopted by the ITU-T are preceded by a *Locking Shift* Information Element.

Unfortunately, these practices do not ensure that all switches recognize all devices. Any Message that is not recognized by the switch is ignored. For this reason, not all ISDN equipment is compatible at all locations.

Service Profile ID (SPID) Assignment

Normally, each telephone line is assigned a single Directory Number. When a customer orders services or features, they are programmed into a *Service Profile* stored at the switch. Any call associated with that line can be assumed to apply only to that customer's Directory Number and Service Profile. When a single ISDN device is connected and serviced this way, the configuration is said to be *point-to-point*.

However, ISDN also supports *point-to-multipoint* configurations, with multiple but dissimilar devices connected to a single line. In many cases, it is not desirable to share the same Directory Number and Service Profile. Consequently, ISDN relies on an initialization procedure for associating Service Profiles with individual Terminating Equipment, rather than lines.

Terminating Equipment that support this procedure are said to be *Auto-Initializing.* The phone company gives an ISDN customer a Service Profile ID (SPID) up to twenty digits long. The customer programs the number into the Terminating Equipment, which sends it to the switch. The switch associates the SPID with a specific Service Profile and Directory Number, and returns a corresponding *Endpoint ID* to the Terminating Equipment. When the switch sends SETUP Messages to a line configured point-to-multipoint, it includes the Endpoint ID, and only matching Terminating Equipment respond.

NOTE: NI-1 Switch Types are always configured for multi-point operation.

CHAPTER 3: PROVISIONING AND OPERATION

The instructions for many ISDN-BRI communications devices may specify *Provisioning* required of the telephone company. Provisioning is a means of configuring the ISDN switch so it knows what kind and how many calls communications devices can support, up to the limits imposed by ISDN-BRI technology. Provisioning also specifies various Supplementary Services, such as call appearances, display support, etc.

The Simulator provides the most common services supplied for the selected Switch Type. Most communications devices should operate correctly with default provisioning, which is retained in a Terminal Service Profile (TSP). The Simulator TSP has a fixed and a variable part. The following fixed provisioning is established for all Switch Types:

B Channels:	2
B1 Call Types:	CMV, CMD (All Bearer Services)
B2 Call Types:	CMV, CMD (All Bearer Services)

The variable part of the TSP may be changed using the Windows based software supplied with the ILS-2000. Not all variable settings are applicable for all Switch Types. The settings are,

D Channel X.25 PHF:	None, Permanent(PVC),Dial-up(SVC)
B Channel:	NONE, Permanent B1, Permanent B2, Permanent Both, Loopback
Phantom Power:	ON, OFF (ETSI)
Caller IDentification:	ON/OFF
Terminal Display Text:	ON/OFF
Multi-Point:	ON/OFF
EKTS:	ON/OFF
Call Appearances:	1-15, 0 = OFF
KEY HOLD:	OFF,ON:AUTO-DROP,ON:AUTO-HOLD
ACO:	ON,OFF

These settings are fully described in the following sections.

Configuration Software Installation

The ILS-2000 configuration software is supplied on a 3.5-in diskette. This diskette has a program that is installed and run under Windows 3.1, Windows for Workgroups 3.11, or Windows 95. To install this software, place the diskette into a 3.5-in disk drive and from Program Manager, select **File** / **Run** / **x:setup.exe**, where x is the name of your 3.5-in disk drive. During

installation, a message may appear saying that a certain file could not be installed because it is already installed and in use. Continue with the installation until complete. A Program Window will be created that is labeled ILS Configuration and includes an icon labeled ILS Configuration. Double click on this icon to start the software (see Figure 1) and provision the ILS-2000.

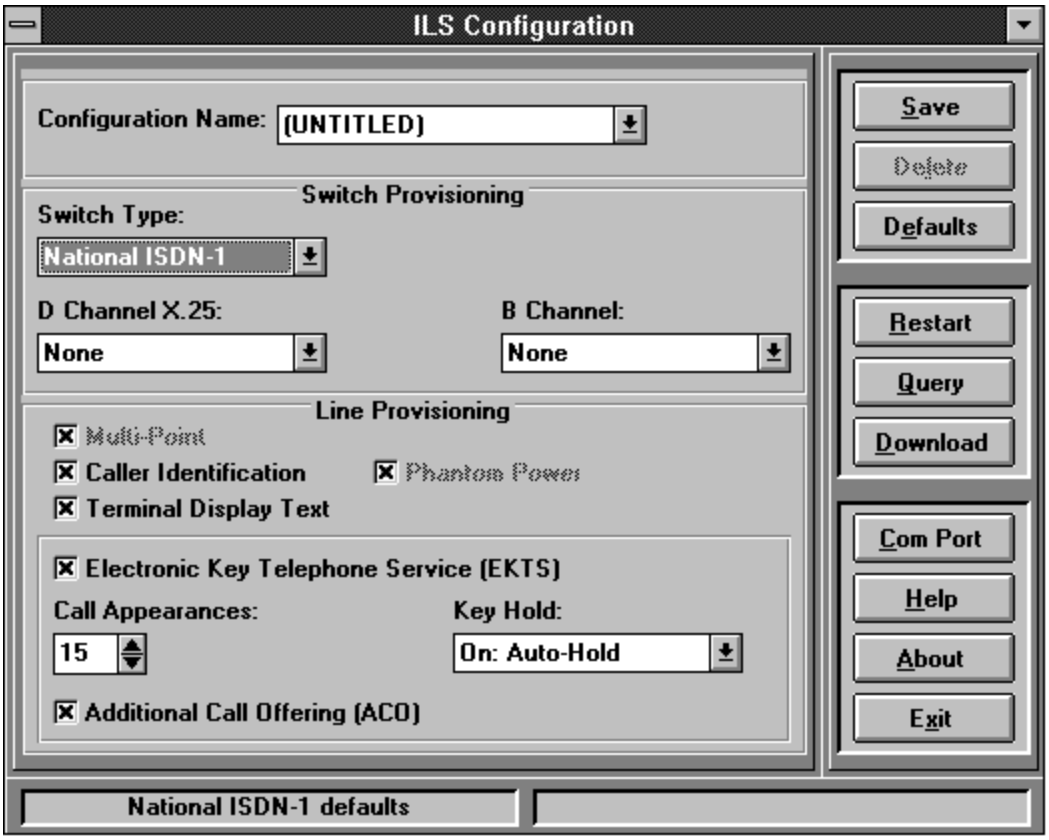

Figure 1. Configuration Software

The ILS-2000 Configuration software will attempt to query the ILS-2000 via COM1, the default communications port. If a serial cable is connected to COM1 and the ILS-2000, the loaded configuration will appear on the screen. If an error message appears, follow the instructions as required. i.e. If the communications port is other than the default of COM1, select another port as necessary. When a valid query has been completed, the Configuration Name will appear as QUERY, with Switch and Line Provisioning settings shown. No attempt to compare against a stored value is done. Two message boxes at the bottom of the screen will aid the user in provisioning of the ILS-2000. The lower left hand message box will display status messages at different times, such as QUERY, DOWNLOAD, National ISDN-1 defaults, and other messages. The lower right hand message box provides short messages about the feature under the cursor, such as, Save User configuration, when the cursor is over the Save button. It also displays a time bar when downloading or querying.

General Operation

Provisioning of features using the ILS-2000 configuration software allow the user to select from several stored configurations, as well as allow the user to store other configurations as needed. If a stored configuration is selected, and any feature is changed, the Configuration Name changes to (Untitled). If you attempt to exit the program without saving the configuration, you will be prompted to do so.

Defaults

To configure default provisioning, based on the selected Switch Type:

STEP 1 Run the Windows based configuration software.

STEP 2 Select the SWITCH TYPE.

STEP 3 Select DEFAULTS.

STEP 4 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Important: When the Simulator configuration is changed using the Windows based configuration software, always reinitialize any connected devices.

Switch Type

The Simulator is configured at the factory for National ISDN-1 protocol. To simulate the AT&T 5ESS Custom, ETSI or other future protocols, you must change the Simulator's Switch Type.

Switch Type	Emulation
National ISDN-1	NI-1
AT&T Custom	AT&T Custom
DMS100	DMS Custom
ETSI	NET3

STEP 1 Run the Windows based configuration software.

STEP 2 Select the Switch Type.

STEP 3 Select DEFAULTS (if you want the default settings for the selected switch)

STEP 3 Remove all communications devices from the Simulator and select the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

STEP 4 Reconnect all communications devices.

Important: When the Simulator configuration is changed, always reinitialize any connected devices. All devices must be compatible with the selected switch protocol.

D Channel X.25

Packet Handling Function (PHF)

ISDN-BRI permits the use of the 16Kbs D Channel, usually reserved for ISDN signaling, to exchange X.25 LAP-B user data with a host system. While few applications for personal communications devices exploit this service, it is available on some terminal adapters and integrated into some telephone sets.

X.25 packet data is offered as an ISDN-BRI service, because the telephone company configured their network with it before any protocol had become popular. It seems unlikely that X.25 will become more popular now that it is available via ISDN-BRI. In fact, most Terminal Adapters that transport packet data across ISDN-BRI lines do so by sending their preferred packet protocol over a 64Kbs B Channel during a Circuit Mode Data call.

One severe limitation of using X.25 LAP-B protocol on the D Channel is that it must share the bandwidth, or available throughput rate, with Call Control signaling packets and other X.25 traffic on a multi-point line. For this reason, the telephone company does not assure X.25 LAP-B data throughput exceeding 9600 baud.

There are three methods for establishing a D Channel X.25 Packet Mode Data (PMD) call. The first, but least used, is to negotiate the call using ISDN-BRI Call Control signaling. The other two methods employ X.25 Virtual Circuit channel negotiation with the telephone company's Packet Handling Function (PHF), or host computer.

The second method, referred to as Semi-permanent Virtual Circuit or SVC, employs a precursor to ISDN Call Control. Specific X.25 packet formats are used to initiate calls, confirm "connections", and clear calls when completed. This method allows dial up for outgoing calls and notification of incoming calls based on a Directory Number.

The third method of X.25 call is Permanent Virtual Circuit or PVC. This method does not employ any form of call control, but simply establishes a constant virtual circuit between two fixed nodes whenever both nodes are active.

The ILS-2000 Line Simulator supports a single channel for a Semi-Permanent or Permanent Virtual Circuit connection between Port 1 and Port 2. To demonstrate these services,

STEP 1 Run the Windows based configuration software.

STEP 2 Select the D Channel X.25 setting.

STEP 3 Change the setting to SVC (for dial-up services) or PVC (for a permanent connection). Select OFF if X.25 functions are not required.

STEP 4 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

STEP 5 Connect a terminal that supports X.25 data on the D Channel to Port 1 and another to Port 2. When using PVC, the terminals should automatically negotiate an open X.25 channel with the ILS-2000's PHF simulator. When using the SVC setting, dial the Directory Number assigned to the X.25 terminal at the other port to establish the connection.

NOTE: Some terminals require that you send an X.25 RESET command manually before the terminal will establish a PVC connection.

B Channel Provisioning

Some ISDN-BRI communications devices, usually LAN gateways and other Terminal Adapters, do not use ISDN Call Control to establish calls or allocate B Channels. These devices assume that one or more B Channels are permanently connected or "nailed up" to a fixed destination. When using real ISDN-BRI lines, one or more permanently provisioned B Channels are assigned by the telephone company. To establish one or more permanent channels between the Simulator's Port 1 and Port 2, or a LOOPBACK configuration,

STEP 1 Run the Windows based configuration software.

STEP 2 Select the B CHANNEL setting.

STEP 3 **C**hange the setting from NONE, Permanent B1, Permanent B2, Permanent BOTH, or LOOPBACK.

STEP 4 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

When B Channels are permanently allocated in this way, they are not available to any devices that use ISDN Call Control to negotiate channel assignment. You can exploit this fact to test how a device behaves when a line is provisioned for less than two B Channels.

Phantom Power

When the ILS-2000 is configured for ETSI Switch Type, you have the option of turning the Phantom Power Line Provisioning on the "S" interface, ON or OFF.

If any other switch type is selected, the Phantom Power selection will be ghosted and cannot be changed.

To change the Phantom Power setting, follow these steps:

STEP 1 Run the Windows based configuration software.

STEP 2 Ensure the Switch Type is set to ETSI.

STEP 3 Change the Phantom Power setting to the desired state.

STEP 4 Select SAVE to save the configuration.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Caller ID

This service, also referred to as Automatic Number Identification (ANI) or Calling Line Identification (CLID), allows Terminating Equipment with display support or call screening features to identify the calling party before accepting the call.

The ISDN switch knows each user's identity because a SPID or Directory Number is always associated with a specific line and user name. When a user places a call, the switch accesses its database to retrieve the calling number and includes it in the SETUP message sent to the called party. If the called party supports a display, the calling party's name and number may be formatted into ASCII text and sent as well.

When the Simulator's Caller ID setting is set to ON, any calling device, even when it doesn't include a Calling Party Number Information Element in its outgoing SETUP message, is identified by the Simulator and presented to the called party.

To change this setting and test the Caller ID features of a particular device,

STEP 1 Run the Windows based configuration software.

STEP 2 Select Caller Identification.

STEP 3 **C**hange the setting.

STEP 4 Select SAVE to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Note: When CALLER ID is set to OFF, the Calling Party Number is not included in incoming SETUP messages.

Terminal Display Text

Many ISDN-BRI telephones, terminal adapters, and computer applications support a display feature that accepts and shows formatted ASCII text delivered by the network. The text may indicate an invoked feature or explain

an error. Usually the text indicates the name and Directory Number of the called or calling party. If the Terminal uses Call Appearances, the Call Appearance identifier is also displayed for the current call.

Some devices specify a switch provision indicating that the Display feature be enabled or disabled. To change the setting,

STEP 1 Run the Windows based configuration software.

STEP 2 Select the Terminal Display Text setting.

STEP 3 Change the setting.

STEP 4 Select SAVE to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

When set to ON, the Simulator sends formatted display text to every device, which includes the Call Appearance, Called (or Calling) Party Name, and Directory Number.

When the Simulator is configured for National ISDN-1, this text is sent in a *Display Text* Information Element following a *Locking Shift 5* (National Codeset) Information Element. For AT&T devices, the text is sent in multiple *Display Field* Information Elements which follow a *Locking Shift 6* (Network Codeset) Information Element.

If one or more devices do not support display text but others do, enable the Terminal Display Text. The device(s) that cannot support these Information Elements simply ignore them.

NOTE: The Simulator does not send display text if Caller Identification is disabled.

Electronic Key Telephone Service (EKTS)

EKTS is not new and most people are familiar with the office telephones that employ it. With a telephone and switch that support EKTS, multiple Directory Numbers may share the same physical line.

The main protocol difference between standard ISDN devices, or Basic Mode Terminals, and EKTS Mode Terminals is that the former are addressed using the *Called Party Number* Information Element, while the latter support the *Endpoint ID* Information Element. The Called Party Number is simply the Directory Number associated with the physical telephone line when service was established. When an incoming SETUP Message is received, all telephones connected to that line alert the user. The user must then decide which device to use when accepting the call.

Using EKTS services, one or more telephones may be addressed individually. ISDN-BRI terminals send a Service Profile ID (SPID) to the switch during initialization, and the switch returns an *Endpoint ID* (TEI)

Information Element unique to that terminal. The EKTS terminal stores the TEI in its non-volatile memory. All subsequent SETUP messages sent to that line may then address all, some, or only one device using the TEI.

If the communications device does not store a TEI, then the Simulator's EKTS setting should be disabled.

STEP 1 Run the Windows based configuration software.

STEP 2 Select the EKTS setting.

STEP 3 **C**hange the setting.

STEP 4 Select **SAVE** to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Note: EKTS is not available when Multi-Point is disabled.

Multi-Point

When the Simulator is configured for multi-point operation, each line can initialize and support more than one device, using multiple SPID's. However, some devices will not operate on multi-point lines. To change this setting,

STEP 1 Run the Windows based configuration software.

STEP 2 Select the MULTI-POINT setting.

STEP 3 **C**hange the setting.

STEP 4 Select **SAVE** to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Note: This setting is not available for NI-1 Switch Types (which are always operated in multi-point configuration). The default configuration for the AT&T Switch Type is NO. When set to NO, the Simulator does not screen outgoing SETUP messages for the Calling Party Number information element, and incoming SETUP messages are sent point-to-point, not broadcast.

Important: Do not connect more than one device to each Simulator port when MULTI-POINT is set to NO.

Call Appearances

Another feature of many business telephones, specifically EKTS Mode Terminals, is the ability to manage multiple calls at one terminal. The purpose of a Call Appearance is to give the user a method of selecting from one of several calls and offering an indication of each call's current status.

Some devices permit programming of the Directory Number(s) into the terminal and associate one or more Call Appearances to manage each DN. The terminal indicates incoming calls using the received *Called Party Number* Information Element and lighting the first unused (idle) Call Appearance assigned to that DN.

However, a simpler method uses the *Call Appearance* Information Element. With this technique, the switch manages outgoing Call Appearance numbers and assigns incoming Call Appearance numbers.

The Simulator manages a maximum of 15 Call Appearances per terminal, which is the default setting. To change the Call Appearance Call Handling setting,

STEP 1 Run the Windows based configuration software.

STEP 2 Select the Call Appearances setting.

STEP 3 Select the number of Call Appearances (00-15).

STEP 4 Select **SAVE** to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Note: This setting is not available when EKTS is disabled.

Note: A maximum of 4 calls may be on hold with one connected.

When one or more Call Appearances are enabled, the Calling Party Information Element is not included in incoming SETUP messages. **This means Basic Mode (AT&T Custom) terminals must have Call Appearances set to 00 to operate correctly**.

Key Hold

Electronic Key Telephone Service (EKTS) terminals may support Hold, Drop, Transfer, and Conference (HDTC) features. These feature apply to terminals that manage multiple voice calls. Some of these operations are performed by the Simulator.

When a call is placed on hold, the B Channel allocated to that call is released, but not the call's status variables or other switch resources. This means the B Channel may be used for another purpose, and the original call can be quickly reconnected after the B Channel is released from its temporary task. Call hold does not apply to the D Channel.

The Simulator supports both Auto Hold and Auto Drop treatment. This refers to the action performed on an active call when a different call is selected. With auto hold, when one call is active and a different call is selected, the first call is placed on hold. With auto drop, the first call is disconnected.

If your communications device does not support these services, then the Simulator's HDTC setting may be disabled.

STEP 1 Run the Windows based configuration software.

STEP 2 Select the KEY HOLD setting.

STEP 3 Select DROP to enable HDTC services with auto drop treatment. Select HOLD to enable HDTC services with auto hold treatment. Select OFF to disable HDTC services.

STEP 4 Select **SAVE** to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

Note: This setting is not available when EKTS is disabled. While the Simulator recognizes the CONFerence and TRANSfer call control messages, it does not perform these services at this time. The ILS-2000 returns a reject message, as if the service was not subscribed.

Additional Call Offering (ACO)

The ISDN-BRI equivalent to Call Waiting is *Additional Call Offering* or ACO. Terminals that support ACO must be able to perform two functions: first, they must have the ability to generate tones, rather than rely on tones sent on a B Channel from the switch. Second, they must be able to recognize B Channel selection during the connection phase of a call, rather than the setup phase.

If the terminal supports these features, then the switch notifies the terminal of every call, even when both B Channels are busy (a condition referred to as interface busy). The terminal may then start its own alerting tone and, if it supports **CACH** operation, indicate the call visually.

If the user or a prioritizing system chooses to release a B Channel either by hanging up or putting a call on hold, the terminal can accept the new incoming call by issuing a CONNect message. The switch determines which B Channel was released and assigns it to the new call in a CONNect ACKnowledge message.

If your communications device does not support ACO or if you want to test the operation of a device during call blocking, disable this setting.

STEP 1 Run the Windows based configuration software.

STEP 2 Select the ACO setting.

STEP 3 Change the setting.

STEP 4 Select **SAVE** to save the setting.

STEP 5 Remove all communications devices from the Simulator and press the DOWNLOAD button. An automatic RESTART is issued as part of the DOWNLOAD.

NOTE: This setting is not available when EKTS is disabled.

CHAPTER 4: SIMULATOR OPERATION

This section refers to the operation of the ILS-2000 in more detail. Many users of the Simulator will not need to read this section.

When power is first applied to the Simulator, a self-test is performed and the interfaces are initialized. This takes about 60 seconds. Each interface is continuously polled to determine if any devices are connected. The U-SYNC LED is displayed when the initialization of the U port is complete. The S/T initialization is done internally and its status is not shown by the U-SYNC LED.

The Layer 2 *Data Link Controllers* are then reset to the *TEI Unassigned* state and all data link variables are set to zero. Finally, the Layer 3 Call Control database is erased, Simulator configurations are loaded, and the Simulator waits for the arrival of signaling packets on the D Channel.

When the Simulator is processing D Channel packet traffic in this way, the keypad's STATUS LED is illuminated a solid green, which signals that the Simulator's ports now offer ISDN-BRI services.

When simulation begins, any terminals or communications devices connected to the Simulator must request TEI's and establish Multiple Frame operation before they can transfer Layer 3 Call Control packets to the Simulator. The first Call Control Message sequence performed is usually the SPID initialization procedure for acquiring an Endpoint ID.

The Simulator performs ISDN-BRI Call Control using all essential Messages and Information Elements defined for National ISDN-1and the AT&T 5E (option) series switch. *NOTE: Layer 2 Disconnected Mode is supported only when initiated by Terminating Equipment. Layer 1 deactivation and phantom power reverse polarity are not implemented.*

All functions of a circuit-switched call are performed, which includes applying in-band tones and completing B Channel connections. D Channel X.25 Virtual Circuit packet mode calls are also supported. Calls may be originated from either line (called a Port) and may terminate at either line. Up to 5 end-to-end calls may be placed simultaneously.

A diagram illustrating a typical end-to-end ISDN-BRI Call Control Message exchange is shown in Chapter 5.

When Call Control Messages are sent to or returned by the Simulator, the Message type is displayed under the applicable Port and Directory Number.

Some terminals send a *Link Monitor* Receiver Ready packet every 30 to 60 seconds to confirm the integrity of packet operation during periods of inactivity. If simulation is halted when this occurs, the terminal will attempt to restart the Simulator's link controller supporting that terminal. When simulation is continued, the Simulator successfully renegotiates data links with most terminals attempting to do the same, and operation resumes normally.

However, some terminals are designed to report link failures to their Call Control Layer, which may then attempt to recover. If their recovery procedure is not satisfied before various timers expire, they may clear (or dump) any active calls.

Some terminals do not attempt to recover from data link failures, but simply terminate operation. These devices must be momentarily disconnected from the Simulator, then reconnected to initialize them. Other terminals may have a reboot function hidden in an Administration menu.

If a terminal is operated when simulation is halted, the device may store (queue) the Call Control packets in its memory until simulation is resumed and its link controllers have restarted. All stored Call Control Messages are then sent in rapid succession to the Simulator.

Other terminals may respond to a Layer 3 failure by refusing to operate. These, too, must be reinitialized or rebooted.

Note: ISDN-BRI devices are not normally designed to be stopped and started at Layer 2 or 3. Consequently, not all terminals will operate in a predictable manner after simulation is resumed. When in doubt, press RESTART, then reinitialize the devices.

Various test conditions and configurations can cause frequent line errors and low-level protocol violations. When using a real ISDN-BRI line, the Central Office accumulates these errors and discontinues service after a predetermined limit is exceeded. The Simulator attempts to continue service even though there are errors.

After testing with a particular configuration known to cause errors, it is good practice to reinitialize the Simulator and any connected equipment before commencing the next test.

Reinitialize

To reinitialize, power-down the Simulator and disconnect any connected devices. Then power-up the Simulator, allow the unit to complete self-testing, then reconnect the terminal equipment to the simulator.

CHAPTER 5: REFERENCE

Status Indications

Figure 2 shows the ILS-2000 ISDN Line Simulator configured for U Interface operation. Connecting to the U Interface allows synchronization of any communications devices connected downstream.

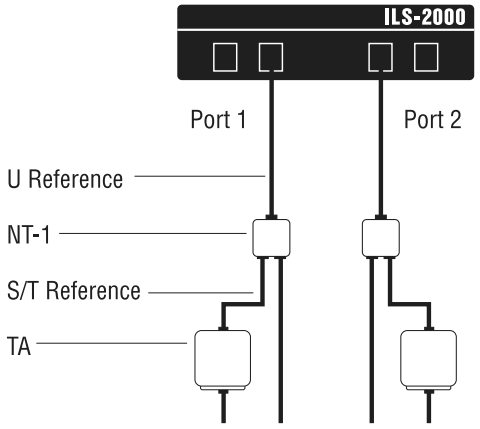

Figure 2. U Interface Operation

The Simulator's U interface status is signaled by the U-SYNC LED, which changes from a blinking green LED to a solid green LED after synchronization is completed.

If your ISDN device needs an NT-1, the Simulator allows your device to use the S/T Interface, as shown in Figure 3. In this case, TE-1 and TA devices are connected directly to the Simulator, as if connecting to an NT-1. The U-SYNCH LED does not function when a device is plugged into the S/T port.

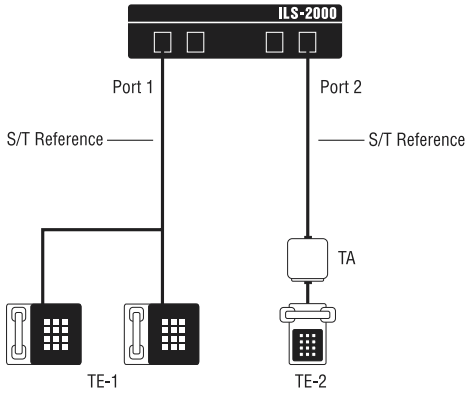

Figure 3. S/T Interface Operation

Dimensions and Panels

Figure 4 shows the unit's front and rear panels.

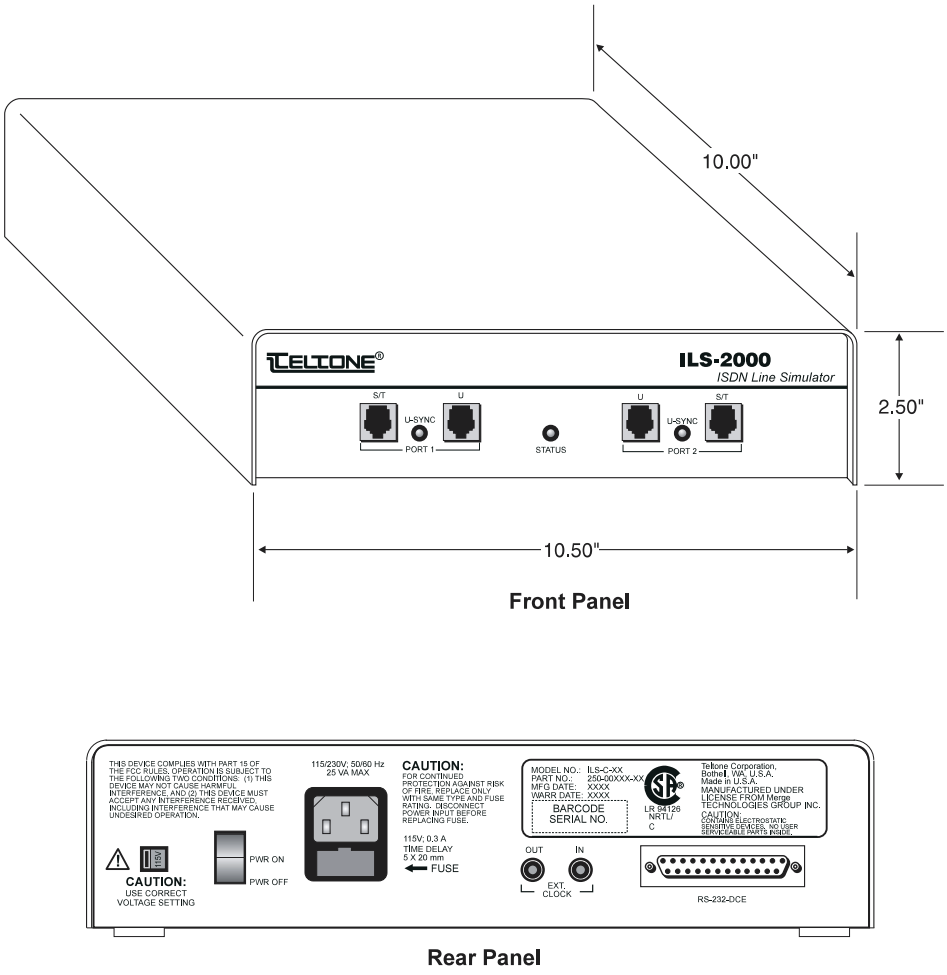

Figure 4. Dimensions and Panels

230VAC Operation

The ILS-2000 is configured at the factory for 115VAC operation using a 300 mA fuse. To enable 230VAC operation replace the 300 mA fuse (and spare) with a 150 mA fuse (2 provided) and move the Voltage Setting switch to 230V.

A 230VAC power cord **IS NOT** provided with the unit.

Supported Call Control Messages

The Simulator supports the ISDN-BRI Call Control messages listed below. For specification documents that describe the function of each message, see the end of this section.

Message codings unique to a particular switch vendor or protocol are followed by the applicable switch type identifier. Not all recognized messages are performed by the Simulator, and are indicated with (*). For example, while the Simulator will recognize the AT&T CONFerence message, it will return a CONFerence REJect message in reply, using the appropriate Information Element Cause code to indicate the service is not available.

ALERTing

CALL PROCeeding

CONFerence (AT&T)*

CONFerence REJect (AT&T)

CONNect

CONNect ACKnowledge

DISConnect

DROP (AT&T)

DROP ACKnowledge (AT&T)

DROP REJect (AT&T)

HOLD (NI-1/NTI)

HOLD (AT&T)

HOLD ACKnowledge (NI-1/NTI)

HOLD ACKnowledge (AT&T)

HOLD REJect (NI-1/NTI)

HOLD REJect (AT&T)

INFOrmation

MANagement INFOrmation (AT&T)

NETwork ESCape

NOTIFY (NI-1/NTI)

PROGress

RECONNect (AT&T)

RECONNect ACKnowledge (AT&T)

RECONNect REJect (AT&T)

REGISTER (NI-1/NTI)*

RELease

RELease COMPlete

RESTart

RESTart ACKnowledge

RETrieve (NTI)

RETrieve ACKnowledge (NI-1/NTI)

RETrieve REJect (NI-1/NTI)

SETUP

SETUP ACKnowledge

STATUS

STATUS ENQuiry

TRANSfer*

TRANSfer REJect

Typical Call Control Sequence

Figure 5 illustrates a common method for depicting a Call Control (Layer 3) message exchange, end-to-end, for setting up and releasing a successful call. The near-end or originating caller is shown on the left, while the far-end or terminating caller is on the right. In this example, the Directory Number is dialed using the keypad.

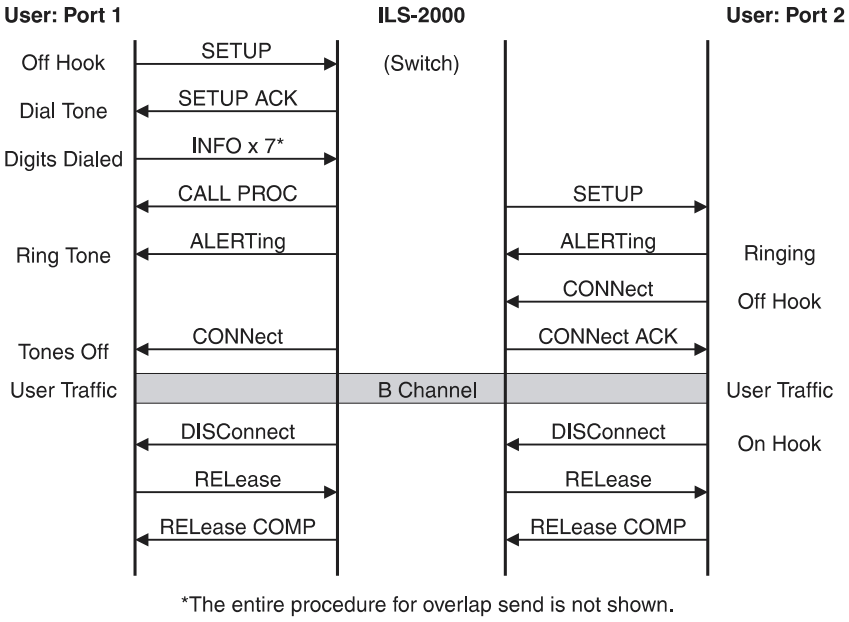

Figure 5. Call Control Message Exchange Example

When User 1 picks up the handset, the terminal sends a SETUP message to the switch indicating the Off Hook condition (Switchhook), type of call (Bearer Capability), the desired channel (Channel ID), the selected Call Appearance, and the Calling Party Number.

The Called Party Number is not included, so the switch returns a SETUP ACKnowledge message indicating the assigned channel and in-band tones applied (Signal=Dial Tone). User 1 dials the number, which is sent in seven consecutive INFOrmation messages (overlap send). Once the switch determines that a valid number has been requested, it returns a CALL PROCeeding message, which may include Display Text, showing the name and requested number.

The switch broadcasts a corresponding SETUP message to the line associated with the dialed number, selecting a B Channel if one is available. Any terminals that match the requested Bearer Capability, and optionally, match the address contained in an Endpoint ID, respond to the SETUP with an ALERTing message and begin ringing. When the switch sends an idle Call Appearance to terminals that support the CACH option, the incoming call is also indicated visually.

After the switch receives User 2 terminal's ALERTing message, it sends a corresponding ALERTing message to User 1 with Signal=Ring Tone.

When User 2 picks up the handset, the terminal sends the switch a CONNect message, indicating the selected channel. The switch returns a CONNect ACKnowledge, and completes a B Channel circuit between the switch and User 2. It then sends a CONNect message to User 1, and completes the B Channel circuit end-to-end. User Application-specific traffic may now be exchanged over the B Channel.

When User 2 replaces the handset, the terminal sends a DISConnect message. The switch removes the B Channel circuit and returns a RELease message. It sends a corresponding DISConnect message to User 1, who returns a RELease message. The switch sends RELease COMPlete to User 2, while User 1 sends RELease COmplete to the switch, ending the call and releasing all allocated resources.

EXT Clock

IN Connected from the "EXT CLOCK OUT" of another Teltone ISDN Simulator for bonding B channels.

OUT Connect to the "EXT CLOCK IN" of another Teltone ISDN Simulator for bonding B channels.

NOTE: Contact Teltone for details regards bonding of B channels.

Troubleshooting

Physical Interface

Problem: U-SYNC LED does not light.

Solution: The U-SYNC LED is an indicator for the U interface only and will not light for the S/T interface.

Solution: Ensure that the device is connected to the U interface and is 2B1Q encoded.

Solution: Ensure that the U interface is terminated into the NT side of an NT-1 or TE.

Solution: Ensure that the terminating device (TE or NT-1) is receiving power.

Solution: Ensure that the loop length between the ILS-2000 and the terminating device is no longer than 1,600 meters.

Problem: TE indicates no S/T synchronization.

Solution: Ensure that no more than 300 feet of loop is between the S/T interface and the TE.

Solution: Ensure that an NT-1 is not installed between the TE and the ILS-2000.

Solution: Ensure that any TE loopback tests are completed or disabled

Problem: How do I loopback the S/T interface?

Solution: The S/T interface acts like an NT-1 device; loopbacks are performed using S and Q subchannel bits per ITU-TRecommendation I.430.

Problem: How do I loopback the U interface?

Solution: Select Loopback as the B Channel setting. Received B-1 and B-2 channel data is routed to the transmit B-1 and B-2 paths at each port.

TEI Assignment

Problem: The TE cannot initialize TEI

Solution: Ensure that the physical interface is synchronized.

Solution: If fixed TEIs (values between1-63) are used, ensure that a different value is used for each TE at both ports (Note: a TEI value of 0 is not supported).

Solution: If the TE permits use of dynamic TEIs, this option is strongly recommended.

Solution: Ensure that no more than 2 TEI's are being initialized for either SAPI 0 or SAPI 16 at each port.

Problem: The TE indicates that TEIs are periodically removed.

Solution: Ensure that duplicate fixed TEIs are not assigned to any device connected to the ILS-2000.

Solution: TEI removal is normal whenever an interface first synchronizes.

Solution: Ensure that no more than 2 TEI's are being initialized for either SAPI 0 or SAPI 16 at each port.

Problem: My CPE device requires a TID to operate

Solution: Program the device's SPID with the first 8 digits of the port's SPID, and then use the last 2 digits of the port's SPID for the device's TID.

Example: For a CPE device connected to port 1, which requires a TID to operate, program the SPID as 08358661 and the TID as 01.

Call Control

Problem: Caller ID doesn't work.

Solution: Ensure that the Caller Identification setting is enabled.

Solution: Ensure that the Directory Number is programmed into the TEI (when required by the TE manufacturer.)

Solution: If the TE has a caller presentation option which permits disabling Caller ID, do not disable this option.

Solution: Some TEs do not permit Caller ID.

Problem: TE indicates an error when attempt is made to place a call.

Solution: Ensure that the Status LED is constant On (green.)

Solution: Ensure that the Switch Type is set to the same protocol as the TE.

Solution: If the TE accepts SPIDs, ensure that the correct SPIDs for the port in use are programmed into TE (Note: do not use the same SPID more than once).

Solution: If the TE accepts SPIDs, ensure that the Multi-Point setting is Yes. (AT&T only)

Solution: For basic mode terminals (AT&T Type A), CACH should be set to off.

Solution: If the TE supports X.25 communication on the D-channel, the D Channel X.25 setting should be selected for either PVC or SVC.

Solution: Ensure that the B Channel setting is None.

Problem: Calls are routed to the same DN when a different DN is dialed.

Solution: When using more than one number per line, make certain that Multi-Point (AT&T only) is set to Yes.

Solution: If the TE accepts 2 SPIDs, do not program the same SPID into the TE more than once.

Solution: If a DN is programmed into the TE, be sure to use the format required by the TE manufacturer (e.g., 7 digits vs 10 digits).

Problem: Every call indicates no channel available or call is blocked.

Solution: Ensure that the B Channel setting is set to None.

Solution: Ensure that the Status LED is constant on (green.)

Solution: Ensure that the correct SPIDs for each port are entered into the TE, if applicable.

Solution: Ensure that the correct DNs for each port are entered into the TE, if applicable.

Solution: When operating four TE (2 on each port), a call from one TE to another on the same port uses both B-channels at that interface. To call one of these TEs from a TE at the other port, ACO must be set to On. (Note: not all TEs support ACO).

Configuration

Problem: How do I select Bearer Capability or call types?

Solution: The following call types are permitted on both B-channels at all times:
Speech
3.1 kHz
audio 7 kHz
audio 56 kbs restricted digital
64 kbs digital

Problem: TE continues to reinitialize (in some cases the Message TEI Remove is observed).

Solution: If the TE initializes more than 1 TEI, or if more than one TE are used, the Multipoint (AT&T only) setting must be must be set to Yes.

Solution: If SPIDs are used, a different SPID for each port must be programmed in the TE.

Solution: If SPIDs are not used, a different directory number for each port must be programmed in the TE.

Problem: Cannot place X.25 call by dialing a number.

Solution: Select SVC for D Channel X.25 setting. Connect one TE to port 1 and the other to port 2. Ensure that both TEs send X.25 Reset packets to the ILS-2000 before attempting the call.

Problem: I have problems using my Motorola BitSurfer when the BitSurfer and ILS-2000 are configured for AT&T 5ESS or DMS100 custom.

Solution: The BitSurfer may be incompatible with the ILS-2000, when set up to emulate an AT&T 5ESS or DMS100 Custom ISDN switch. For reliable operation the BitSurfer ILS-2000 needs to be configured for NI-1 operation.

Problem: Electronic key telephone drops calls when another incoming call is selected.

Solution: Ensure that EKTS is enabled, call appearances is set to the number of call appearances (button/light indicators) on the TE, and that the Key Hold setting is On: Auto-Hold.

Reference Documents

The following specification documents, among others, have been used for the development of the ILS-2000 ISDN Line Simulator.

ITU-T Recommendation Q.931, ISDN Call Control, Layer 3

ITU-T Recommendation Q.921, ISDN LAP-D Protocol, Layer 2

ANSI T1.601, ISDN Physical Layer Specifications, Layer 1

National ISDN Generic Guidelines for ISDN Terminal Equipment on Basic Rate Interface, Bellcore SR-NWT-002661

ISDN D-Channel Exchange Access Signaling and Switching Requirements (Layer 2), Bellcore TR-TSY-000793

ISDN Access Call Control Switching and Signaling Requirements (Layer 3), Bellcore TR-TSY-000268

ISDN Features-Common Switching and Signaling Generic Requirements, Bellcore TR-TSY-000847

ISDN Hold Capability for Managing Multiple Independent Calls, Bellcore TR-TSY-000856

Additional Call Offering for Managing Multiple Independent Calls, Bellcore TR-TSY-000857

Flexible Calling for Managing Multiple Independent Calls, Bellcore TR-TSY-000858

ISDN Electronic Key Telephone Service, Bellcore TR-TSY-000205

AT&T Integrated Services Digital Network (ISDN) Basic Rate Interface Specification, AT&T 801-802-100

ISDN Basic Rate User-Network Interface Specification, Northern Telecom, NIS S208-6, Issue 1.1

Integrated Services Digital Network User-network interface layer 3 Specifications for basic call control, ETS 300 102-1. Issue 1993-10. (ETSI)

Understanding ISDN Applications - Telecommunications Research Associates

Bellcore
Information Exchange Management
445 South Street, Room 2J-125
Morristown, NJ 07960-6438
(201) 829-4785

AT&T Information Network Architecture
AT&T Bell Laboratories
Holmdel, NJ 07733

Northern Telecom, Inc.
4001 East Chapel Hill - Nelson Hwy
P.O. Box 13010
Research Triangle Park, NC 27709
(800) 684-2273

REVISION HISTORY

ICS-C-01

The ILS-2000 replaces the ILS-1000 (ILS-A-01). The ILS-2000 switch types include the AT&T Custom switch type without requiring an upgrade package, and also adds the DMS-100 Custom and ETSI switch types.

Firmware Version 3.42

NOTE: The ILS-2000 incorporated new hardware to support the Phantom Power requirements of the ETSI switch type. Because of this, an ILS-1000 cannot be upgraded to an ILS-2000.

Initial Release

ILS-C-02

The ILS-C-02 replaces the ILS-C-01.

Firmware Version 3.50

Bug Fix: X.25 PVD D-Channel changed from 0 to 1.

Bug Fix: Configuration software incorrectly identified the unit as an ILS-1000.

Firmware Version 3.52

Bug Fix: Q.931 Call Set-up Failures

WARRANTY AND SERVICE

Warranty Information

Teltone warrants this product to be free of defects in workmanship and materials for a period of 1 year.

Return Procedures

If a unit is found to be defective, contact Teltone customer service to obtain a RMA (Return Material Authorization) number and shipping instructions. When returning units, provide the following information:

- Unit model number, unit part number, and serial number (obtained from the Unit ID label).
- Teltone RMA number
- All available fault information
- Complete shipping and billing address
- Repair purchase order

Technical Assistance

For technical assistance on this product, call Teltone technical support at 425-951-3390 or send an email to support@teltone.com.

Maintenance

Cleaning

The unit can be cleaned by using a damp cloth and wiping away any dust or residue on the metal. Always disconnect power before cleaning the unit.

Servicing

The unit should be checked periodically for damage or hazardous conditions.

SPECIFICATIONS

AC Power Input	
Input Voltage	115 +/- 10% VAC *or*
(Selectable via rear panel slide switch)	230 +/- 10% VAC
Frequency	49 to 61 Hertz
Current	Fused @ 300 mA for 115 VAC Fused @ 150 mA for 230 VAC
Connector	IEC 3 Prong Male
Output to power external devices	40 +/- 5.0 VDC 6 watts maximum
U Interface	RJ-45 8 pin modular connector
Protocol	2B1Q (2 Binary 1 Quaternary) @ 80 kbaud +/- 5 ppm
Maximum cable drop	1600 meters (using 24 gauge copper wire)
S/T Interface	RJ-45 8 pin modular connector
Protocol	Pseudoternary, ASI (Alternate Space Inversion)@ 192 kbits/sec +/- 100 ppm
Maximum cable drop	100 meters (using 24 gauge copper wire)
Power Source 1	-40 +/-5 VDC on pins 4 & 5 (negative reference) -40 +/-5 VDC on pins 3 & 6 (positive reference)
Power Source 2	-40 +/-5 VDC on pins 7 & 8 Pin 7 (negative reference) Pin 8 (positive reference)

Maximum power source voltage per ANSI T1.605 is 56.5 VDC

Minimum power source voltage per ANSI T1.605 is 32.0 VDC

Maximum of 6 Watts available power for external devices.

RS-232 interface	DB-25 pin female connector (DCE) 19.2 Bps
Environmental Specifications	
Temperature	
Storage	-40º to +55º C
Operating	0º to 50º C
Humidity	Max 85%
Flammability	Meets UL-94 V-O

Mechanical Specifications

Dimensions	2.5" H x 10.0" D x 10.5" W
Weight	4 lb 15 oz.

Regulatory Compliance

Safety	
United States	UL 1459
Canada	CSA C22.2 No. 225-M90
EMC	
United States	FCC Part 15, Class A

GLOSSARY

5ESS

Medium-to-Large digital end office switch (Class 5). Manufactured by AT&T and introduced in 1981. First AT&T switch to offer Basic Interface ISDN (with the software load 5E4.2) in the 1980's.

AMI (Alternate Mark Inversion)

A Layer 1 line-code scheme used in T1 carrier and ISDN PRI. Zeros are expressed as no volts, and ones are expressed as volts that alternate polarity. AMI was also the foundation for proprietary (Pre-National ISDN) BRI line codes for outside wire, which were limited to distances of about 10,000 feet from the source of the signal.

ASI (Alternate Space Inversion)

A Layer 1 line code specified by the ITU-T for the BRI S/T (inside wire) interface. In ASI, ones are represented by no volts and zeros are expressed as volts which alternate polarity. The beginning and end of each frame is denoted by bipolar violations. Each frame is 48 bits in length. This type of line code is also known as pseudo-ternary signaling.

Analog Signal

Continuously varying with an amplitude which is an analog of the original information, amplitude and thus may have virtually an infinite number of states. Contrasted with a digital signal which has only a very limited number of discrete states.

Analog Transmission

The transmission of a continuously variable signal. Signals are sent through a system, and where the signal strength weakens, repeaters are installed to amplify the signal. However, since in an analog transmission there is no way to differentiate between the :signal and "noise", repeaters amplify both, and noise becomes cumulative in an analog transmission system.

ANI (Automatic Number Identification)

The billing number of the calling party. Provided by the originating switch to the interexchange carrier over equal access trunks (FG-D) for billing.

ANI is also sold by IECs to their direct connect customers, normally in conjunction with ISDN PRI.

ANSI (American National Standards Institute)

A U.S. organization which is chartered to "accredit" standards developed by a wide variety of industry groups without undue influence from any one company. ANSI does not itself develop any standards but accredits those developed by appropriate organizations. For example, ANSI accredits standards for telephone developed by ATIS (Alliance for Telecommunications Industry Solutions) under the auspices of Committee T1, standards for cellular radio developed by EIA/TIA (Electronic Association), etc.

Application Layers

Open Systems Interconnect (OSI) reference model top layer - layer seven. This end user layer sets up logical connections for the passing of Application Service Elements (ASEs) requests and responses between communicating entities.

ASCII (American Standard Code for Information)

A standard governing the representation of various characters as a sequence of binary digits. Primarily refers to text in personal computers.

Asynchronous Transmission

Data is sent character by character. The receiver and transmitter are synchronized for each individual character via a start and stop pulse. Asynchronous transmission is normally found on dial up circuits, usually at speeds between 300 and 19,2000 bps.

B Channel

A 64 Kb/s (DS0) ISDN user-to-network channel. Used in both the Basic Interface and the Primary Rate Interface. Carries a voice, data or image call, but not the signaling for the call. Normally circuit-switched by the network, but can be a switched or dedicated access to a packet-switched network. When circuit switched, may carry multiplexed information streams, but only to the same destination.

B-ISDN (Broadband ISDN)

This network standard from ITU-T (Formerly CCITT) an ANSI T1 committees is an evolution of N-ISDN to provide existing and new services for voice, data, and video in the same network at digital rates to 150 Mb/s and 600 Mb/s initially. Eventually B-ISDN could become one network for both circuit and packet using ATM to provide bandwidth on demand.

Bandwidth

A measurement of transmission capacity; the larger the bandwidth, the larger the amount of information or transmission medium can carry. Analog transmission is measured in Hertz, or cycles per second. Digital transmission is measured in bits per second.

Baud

A unit of signaling speed, equal to the number of signal events per second. In binary systems, one baud equals one bit per second. In sophisticated systems, one signal event may transmit more than one bit.

Baud (or Baud Rate)

A unit of modulation rate, equal to the number of signal events (or Symbols) per second. A "signal event" is a change in an information-bearing signal or waveform, which represents some number of encoded bits. Where two signal values are used as Symbols (such as a combination of amplitude, frequency or phase), then each Symbol represents one bit, and the "Baud Rate" will equal the Bit Rate.

Bearer Capability

Information carrying capability requested by the user and provided by the network. For example, Bearer Capability of Voice with possible echo-suppression and loss-insertion is different than bearer capability of digital information where the bits are carried transparently.

Bit (Binary Digit)

A binary character, consisting of one of two possible values: 0 or 1.

BRI (Basic Rate Interface)

An ISDN User-to-Network Interface consisting of three full-duplex channels; two 64 Kb/s B Channels and one 16 Kb/s D Channel (2B+D). The 2B+D U interface requires a single twisted pair of wire, while the 2B+D S/T interface requires two twisted pairs of wire.

CCITT (Consultative Committee on International Telephone & Telegraph)

Comite Consultatif International Telegraphe et Telephone (French for "International Telephone and Telegraph Consultative Committee"). Formerly, an international standards body charted by the United Nations. Now called ITU-T (International Telecommunication Union-Telecommunication sector.)

Centrex

Service created by software in the telephone company's local office which simulates multiple virtual PBXs. Some telephone companies use their own marketing names for local marketing of this service (i.e. ESSX, Intellipath, IIN, Centro, Plexar).

Channel

Communication path which may be sending in one direction only (simplex) or both directions (duplex) and both directions simultaneously (full duplex). Most advanced networks today (ISDN, Frame Relay, ATM, etc.) are full duplex.

CMD (Circuit Mode Data)

The connection of a fixed bandwidth circuit established from point A to point B through a network for the duration of a telephone call. This connection supports end-to-end data.

CMV (Circuit Mode Voice)

The connection of a fixed bandwidth circuit established from point A to point B through a network for the duration of a telephone call. This connection supports end-to-end voice.

CPE (Customer Premises Equipment)

In the U.S., end-user equipment that may not be owned by the local exchange; Carrier equipment that resides on the end user's side of the network interface boundary established by Computer Inquiry II.

D Channel

An ISDN Statistically-multiplexed user-to-network channel. It carries Q.931 signaling messages to control the B channels and/or X.25 packet-switched user data. It is defined as a 16 Kbp/s channel in the Basic Interface and 64 Kbp/s channel in the Primary Rate Interface.

dBm (Decibel referencing 1 milliwatt)

A measure of power, as a decibel reference to 1 milliwatt. dBm is based on 600 ohms impedance and 1000 Hz frequency. 0 dBm is 1 milliwatt at 1000 Hz terminated by 600 ohms impedance.

Digital

The representation of data (0 and 1 bits) via electrical pulses. This form of transmission offers faster speed, greater accuracy and flexibility than analog transmission.

Digital Information

A stream of binary (0's and 1's) bits. Voice, documents, and even television can be samples, quantized and converted to a digital bit stream.

DMS-100

NT large digital end office (class 5) switch. First commercially successful digital switch employed by telephone companies in the United States.

ETSI (European Telecommunications Standards Institute)

European Telecommunications Standards Institute. Formed in 1988 by the member administrations of CEPT to broaden European Standards participation to include manufacturers, research centers, private service providers, and user associations, as well as Post and Telecommunications Administrations. ETSI has more than 250 members.

Hertz (Cycles Per Second)

A unit of frequency equal to one cycle per second and named for Heinrich Hertz, a German mathematician.

I.331

I.331 is the ITU-T specification for the ISDN numbering plan. This is also known as E.164.

I.430

The ITU-T Layer 1 specification for the ISDN BRI S/T interface, which consists of 4 wires. The S/T interface uses Alternate Space Inversion (ASI) line coding.

I.431

The ITU-T Layer specification for the Primary Rate Interface. See PRI, T-1 and E-1.

I.440

The ITU-T specification, commonly know as Q.920, which describes the general network aspects of the LAP-D protocol (also known as DSS1).

I.441 (Q.921)

ISDN user-network interface - (D Channel) Layer 2 specification describing the operational procedures of LAPD. Part of DSS1.

I.450

Also known as Q.930; the ITU-T specifications describing the general network aspects of the ISDN D-Channel Layer 3 protocol.

I.451 (Please refer to Q.931)

I.452

The ITU-T specifications for the 1988 specifications for the ISDN supplementary services (Q.932). These services are now specified in Q.932 and Q. 957.

IEC (Interexchange Carrier)

A long distance company such as AT&T, MCI, Sprint, or hundreds of smaller companies.

Inband Signaling

Controls Signals that travel on the same circuit and uses the same frequencies as the call.

ISDN Address

The full address of an ISDN-capable device, consisting of the site's ISDN numbering plan and any additional terminal-specific digits signifying a particular user (NT2 and TE1).

ITU (Internal Telecommunications Union)

The principal international standards organization chartered by the United Nations and supported by treaty agreements among member nations. The ITU is the parent organization for the ITU-T (Formerly CCITT) and the ITU-R (formerly CCIR). In addition, the ITU has two other permanent organs: the International Frequency Registration Board (IFRB), and General Secretariat; founded in 1865

LAPB (Link Access Procedure Balanced)

Link Access Procedure B. The Layer 2 protocol defined for X.25.

LAPD (Link Access Procedure D)

Layer 2 protocol defined in CCITT recommendations I.440/441/442 cross referenced as Q.920/921/922. Reliably transfers blocks of information across a single Layer 1 link. Unlike LAP and LAPB, supports multiplexing or different connections at Layer 2.

Layer 1

The Physical Layer in the OSI Reference model. Includes transmission of signals and the activation and deactivation of physical connections.

Layer 2

The Data Link layer in the OSI Reference model. Includes synchronization and some control over the influence of errors within the physical layer.

Layer 3

The Network layer in the OSI Reference model. Includes routing and switching functions.

Layer 4

The Transport layer in the OSI Reference model. Uses Layers 1 to 3 to provide an end-to-end service with the required characteristics for the higher layer functions.

Layer 5

The Session layer in the OSI Reference model. Allows presentation entities to organize and synchronize their dialogue and to manage their data exchange.

Layer 6

The Presentation layer in the OSI Reference model. Includes data formatting and code conversion.

Layer 7

The Application layer in the OSI Reference model. Provides the means by which the user programs access the OSI environment and may contain part of these user programs.

LEC (Local Exchange Carrier)

Local Exchange Company. A telephone company affiliate of a Regional Bell Operating Company or an independent telephone company such as Southern New England Telephone (SNET), Cincinnati Bell, GTE (Contel), United, Centel, Rochester Telephone, Wamego Telephone, or hundreds of others.

Line

A communication path between a switch and one end user. Analog lines are termed tip and ring and carry one telephone call. ISDN lines are called Digital Subscriber Lines and can carry several calls.

Loop

Pair of wires connecting the subscriber to the Telephone Company central office.

Modem (Modulator/Demodulator)

A device which converts data signals into a form suitable for transmission over a communications medium and which recovers the data from the received communication link. This term is a contraction of MOdulator/DEModulator. "Voiceband" Modems are a special class of Modems which convert data signals into TONES within the bandwidth allocated for voice. Direct Digital Interfaces are another class of modems which convert data into the format needed for transmission over digital radio channel.

MPEG (Motion Picture Experts Group)

the emerging ISO standard for the compression and coding of motion video. Also, the name of the standards group developing the standard.

There are three versions of MPEG:

MPEG-1 operates up to about 2.5 Mb/s and is suitable for storage on digital storage media, e.g. hard disks, CD-ROMs, etc.

MPEG-2 operates at higher bit rates for broadcast-quality video

MPEG-4, still underdevelopment, will standardize video compression for video conferencing on analog phone calls.

N-ISDN (Narrowband ISDN)

Narrowband Integrated Services Digital Network. Includes basic interface (2B+D or BRI) and primary rate interface (23B+D or PRI). Copper based at speeds at or below 1.5 Mb/s.

NT1 (Network Termination 1)

In the U.S., a customer-owned device that converts from external telephone company transmission format (U interface) to internal building transmission format (T interface). Concerned only with Layer 1. Should contain loopback and other maintenance capabilities to enable problems to be isolated to the telephone network or customer's equipment. NT1 for basic interface contains digital hybrid circuitry.

NT2 (Network Termination 1 and 2)

Customer premises device to fan out a user-to-network (T) interface into multiple T or R interfaces. Concerned with Layer 1, 2, and 3. Examples are a PBX, Key system, LAN, and terminal controller.

OSI (Open System Interconnection Reference Model)

Open Systems Interconnection. The International Standards Organization (ISO) model of how data communications systems can be interconnected. Communication is partitioned into seven functional layers. Each layer uses and builds on the services provided by those below it.

Out-of-Band Signaling

A system that uses a separate communications channel or frequencies outside of voice band for signaling. Digital examples are the ISDN D channel and common channel signaling.

Packet

A grouping of data, typically from 1 to 512 characters in size which usually represents one transaction. A packet is always associated with an address header and control information. The term "Packet" is usually used to refer to a Layer 3 data unit in X.25.

PBX (Private Branch eXchange)

A customer premises telephone switch connecting 20 or more station sets to each other to the public network and possibly to a private network.

PRI (Primary Rate Interface)

An ISDN User-to-Network Interface. In North America and Japan, it is based on T1 Carrier. In North America, it consists of twenty-four full-duplex channels: Twenty-three 64 Kb/s B-Channels, and one 64 Kb/s D-Channel ... hence the acronym "23B+D." The physical media is two twisted-pairs of wire.

Q.931 (I.451)

Layer 3 protocol for out-of-band message-oriented signaling across user-to-network interface. Originally specified for the D channel of the ISDN Basic Interface (BRI) and Primary Rate Interface (PRI).

Q.932

Q.931 signaling protocol extensions to add supplementary services. These include custom calling features.

RBOC (Regional Bell Operating Company)

Seven operating or holding companies into which the Bell System's local telephone companies were assigned as a result of the Modified Final Judgement (MFJ) in 1982. These companies were assigned the management of local exchange companies originally owned by AT&T. Distributed regionally, they included Pacific Telesis, U S West, Southwestern Bell Telephone, Bell South, Bell Atlantic, Ameritech, and NYNEX.

Ring Back

Also known as audible alerting. The tones the calling party hears while the called party's phone is ringing.

RS-232C

Collection of specifications defining electrical and mechanical interfaces between terminals, computers, and modems.

S Interface

ISDN Interface between station equipment and NT2.

Signaling

Communication between switches, or switches and end points, to setup, manage, and tear-down calls. Signaling methods include dial pulse (rotary dial), dual-tone multifrequency (DTMF) (touchtone), and digital "packet" technology (ISDN, SS7).

SPID

The Service Profile Identifier is used to identify a specific ISDN set when more than one ISDN set has been attached to the same central office line. In most cases, only one ISDN set will be assigned to a line, and the SPID is not used by the switch.

SS7 (Signaling System Number 7)

An international, standard, common channel signaling system. SS7 is used between public network switches (replacing per-trunk signaling), local exchange carrier switches, interexchange carrier switches, and (increasingly) between local and interexchange carrier networks.

Switch

Generic term for machines that switch telephone calls from/to telephones and/or trunks. Includes private branch exchanges (PBX) as well as other premises based systems, and public network central office machines such as local exchange switches, tandem switches, toll switches, interexchange carrier switches, and gateway switches.

Synchronous Transmission

Data communication protocol set where data is sent continuously. The receiver and transmitter are in constant bit synchronization. Character (byte) synchronization is achieved by a Layer 2 Flag character transmitted at the start of each block. Synchronous transmission is normally found on the faster circuits, e.g. rates of 4.8 Kb/s and above.

T Interface

ISDN Interface between station equipment and NT1. For the Basic Interface this is a 4 wire connection limited to 1 KM.

TA (ISDN) (Terminal Adapter)

ISDN Customer-owned protocol converter. Converts from a standard non-ISDN interface (e.g. X.25, RS-232) to ISDN S/T interface.

TE (Terminal Equipment)

ISDN equipment category including TE1s, TAs and TE2s.

TE1 (Terminal Equipment type 1)

Terminal Equipment meeting ISDN interface specifications such as ISDN phones, ISDN terminals, etc.

TE2 (Terminal Equipment type 2)

Terminal Equipment providing interfaces other than ISDN, for example, non-ISDN equipment. Needs an appropriate terminal adapter (TA) to connect to ISDN.

TEI (Terminal Endpoint Identifier)

An ISDN device's Layer 2 address that is unique on a passive bus. Used to establish independent data inks between the switch and each device on a passive bus.

Tip/Ring

The negative (tip, or ground) and positive (ring, or battery) wires of an analog lines. Refers to an analog line, rather than a digital line.

Twisted pair

Twisted pair insulated copper wire is used extensively in the telco network to support analog-grade communications, such as the type of wiring generally supplied to serve a local loop for a home. Twisted pair is normally .035-.016 inches (22-26 AWG). This type of facility is used by the telco to supply ISDN BRI to an individual or centrex subscriber.

U Interface

A two-wire interface required by the FCC (not the ITU-T) between the Local Exchange Carrier and the customer's NT1. Specification completed during 1Q87 by ANSI T1D1.3.

X.25

ITU-T recommendation specifying how user equipment (DTE) is to connect to a public, packet-switched network (DCE). Specifies Layer 1, 2, and 3 Protocols.